L Number	Hits	Search Text	DB	Time stamp
1	1942	(MR or magnetor$6) adj3 sensor	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:14
2	217	((MR or magnetor$6) adj3 (film or layer)) near30 (conductor or conductors)	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:17
3	87	((MR or magnetor$6) adj3 sensor) and (((MR or magnetor$6) adj3 (film or layer)) near30 (conductor or conductors))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:15
4	30	((MR or magnetor$6) adj3 (film or layer)) near20 ((between or interpos$4) adj10 (conductor or conductors))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:16
5	11	(((MR or magnetor$6) adj3 sensor) and (((MR or magnetor$6) adj3 (film or layer)) near30 (conductor or conductors))) and (((MR or magnetor$6) adj3 (film or layer)) near20 ((between or interpos$4) adj10 (conductor or conductors)))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:16
6	22	((MR or magnetor$6 or pinned) adj3 (film or layer)) near50 (resist$5 adj8 rate)	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:31
7	0	((((MR or magnetor$6) adj3 sensor) and (((MR or magnetor$6) adj3 (film or layer)) near30 (conductor or conductors))) and (((MR or magnetor$6) adj3 (film or layer)) near20 ((between or interpos$4) adj10 (conductor or conductors)))) and (((MR or magnetor$6 or pinned) adj3 (film or layer)) near50 (resist$5 adj8 rate))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:18
8	165797	CIP or (current adj8 (in$2plane or (in adj3 plane)))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:31
9	0	(((MR or magnetor$6) adj3 (film or layer)) near20 ((between or interpos$4) adj10 (conductor or conductors))) and (CIP or (current adj8 (in$2plane or (in adj3 plane))))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:19
10	0	(((MR or magnetor$6 or pinned) adj3 (film or layer)) near50 (resist$5 adj8 rate)) and (CIP or (current adj8 (in$2plane or (in adj3 plane))))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:19
11	256	((MR or magnetor$6 or pinned) adj3 (film or layer)) near50 (resist$5 adj8 chang$5)	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:20
13	0	(CIP or (current adj8 (in$2plane or (in adj3 plane)))) and ((((MR or magnetor$6) adj3 (film or layer)) near20 ((between or interpos$4) adj10 (conductor or conductors))) and (((MR or magnetor$6 or pinned) adj3 (film or layer)) near50 (resist$5 adj8 chang$5)))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:20
14	0	(((MR or magnetor$6) adj3 (film or layer)) near20 ((between or interpos$4) adj10 (conductor or conductors))) and (CIP or (current adj8 (in$2plane or (in adj3 plane))))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:20
15	0	(((MR or magnetor$6) adj3 (film or layer)) near30 (conductor or conductors)) and (CIP or (current adj8 (in$2plane or (in adj3 plane))))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:21

16	62	((MR or magnetor$6) adj3 (film or layer)) near40 pinned	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:21
17	18	((MR or magnetor$6) adj3 (film or layer)) near40 (ferromagnetic adj5 pinned)	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:23
18	14	((MR or magnetor$6) adj3 (film or layer)) near40 (pinned adj5 ferromagnetic)	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:23
19	22	(((MR or magnetor$6) adj3 (film or layer)) near40 (ferromagnetic adj5 pinned)) or (((MR or magnetor$6) adj3 (film or layer)) near40 (pinned adj5 ferromagnetic))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:23
20	18	((MR or magnetor$6) adj3 (film or layer)) near40 ((ferromagnetic adj5 free) or (free adj5 ferromagnetic))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:23
21	13	((((MR or magnetor$6) adj3 (film or layer)) near40 (ferromagnetic adj5 pinned)) or (((MR or magnetor$6) adj3 (film or layer)) near40 (pinned adj5 ferromagnetic))) and (((MR or magnetor$6) adj3 (film or layer)) near40 ((ferromagnetic adj5 free) or (free adj5 ferromagnetic)))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:24
22	3015	(spin near3 valve) or spin$2valve	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:24
23	11	(((((MR or magnetor$6) adj3 (film or layer)) near40 (ferromagnetic adj5 pinned)) or (((MR or magnetor$6) adj3 (film or layer)) near40 (pinned adj5 ferromagnetic))) and (((MR or magnetor$6) adj3 (film or layer)) near40 ((ferromagnetic adj5 free) or (free adj5 ferromagnetic)))) and ((spin near3 valve) or spin$2valve)	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:24
12	7	(((MR or magnetor$6) adj3 (film or layer)) near20 ((between or interpos$4) adj10 (conductor or conductors))) and (((MR or magnetor$6 or pinned) adj3 (film or layer)) near50 (resist$5 adj8 chang$5))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:28
30	0	(((MR or magnetor$6 or pinned) adj3 (film or layer)) near50 (resist$5 adj8 rate)) and (CIP or (current adj8 (in$2plane or (in adj3 plane))))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:31
31	257	((MR or magnetor$6 or pinned) adj3 (film or layer)) near100 (resist$5 adj8 chang$4)	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:32
32	5	(CIP or (current adj8 (in$2plane or (in adj3 plane)))) and (((MR or magnetor$6 or pinned) adj3 (film or layer)) near100 (resist$5 adj8 chang$4))	USPAT; EPO; JPO; DERWENT; IBM_TDB	2004/03/17 16:32

MR film = ferromg. pinned + ferro. free

r shield film.

(5) The MR film 11 may be an AMR film provided with a single layer structure, or a SVMR or other GMR film provided with a multilayer structure of a ferromagnetic thin-film layer (free layer)/a nonmagnetic thin-film metal layer/a ferromagnetic thin-film layer (pinned layer)/an anti-ferromagnetic thin-film layer laminated in this order or reversed order.

(6) The magnetic domain control films 14 may be in general made of CoPt, CoCrPt or the like. But material for making the films 14 is not limited to them.

(7) The second under layers 13 may be made of TiW, Cr, CrTi or the like. But material for making the film 13 is not limited to them.

(8) The first under layers 12 may be made of Ta, Hf, Nb or Zr. If there are the first und

MR film = ferro: pinned + ferro: free

c
heads, whereby improved asymmetry characteristics can be expected.

(13) According to the present invention, a MR sensor, a thin-film magnetic head and a thin-film wafer with a plurality of the thin-film magnetic heads has a MR multi-layered structure including a non-magnetic material layer, first and second ferromagnetic material layers (free and pinned layers) separated by the non-magnetic material layer, and an anti-ferromagnetic material layer formed adjacent to and in physical contact with one surface of the pinned layer, the one surface being in opposite side of the non-magnetic material layer, the multi-layered structure having ends in a direction parallel to a magnetically sensitive surface or an air bearing surface (ABS),

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CIP + Resistance changes

ic domains. Resistance is lower when the relative magnetic moments are parallel and higher when the magnetic moments are antiparallel. Because of their superior sensitivity, CPP spin valves are generally preferred over CIP (Current-In-Plane) spin valves.

(7) Commonly assigned U.S. Pat. No. 5,898,547 of Fontana et al. (the '547 patent), discloses a magnetoresistive read head (with an MTJ sensing element) for use in an integrated read/write head of a disk drive. The sensing element of the read head is recessed from the sensing surface of the head to minimize damage to the sensin

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CIP + Resistance change

o the film plane of each of the layers of the multilayer film 28. This direction of the sensing current flow is referred to as a "CPP type".

(38) In this magnetic sensing element, when the sensing current is supplied to the pinned magnetic layer 24, the nonmagnetic intermediate layer 25 and the free magnetic layer 26, and a leakage magnetic field is applied in the Y direction from the recording medium such as a hard disk or the like, which moves in the Z direction, magnetization of the free magnetic layer 26 is changed from the X direction to the Y direction. As a result, the electric resistance changes (referred to as a "magnetoresistive effect") based on the relation between the change in the magnetization direction of the free magnetic layer 26 and the pinned magnetization direction of the pinned magnetic layer 24. Thus, the leakage magnetic field from the recording medium is sensed by a change in the voltage based on the change in the electrical resistance value.

(39) In the present invention, as shown in FIG. 1, the current limiting layer 27 is formed between the free magnetic layer 26 and the second electrode layer 33.

(40) In the present invention, the current limiting layer 27 has, for example, the film structure shown in FIG. 7. FIG. 7 is a partial schematic drawing showing the antiferromagnetic layer 23, the pinned magnetic layer 24, the nonmagnetic intermediate layer 25, the free magnetic layer 26, and the current limiting layer 27.

(41) As shown in FIG. 7, the current limiting layer 27 comprises, as a base material, an insulating material layer (insulating portion)